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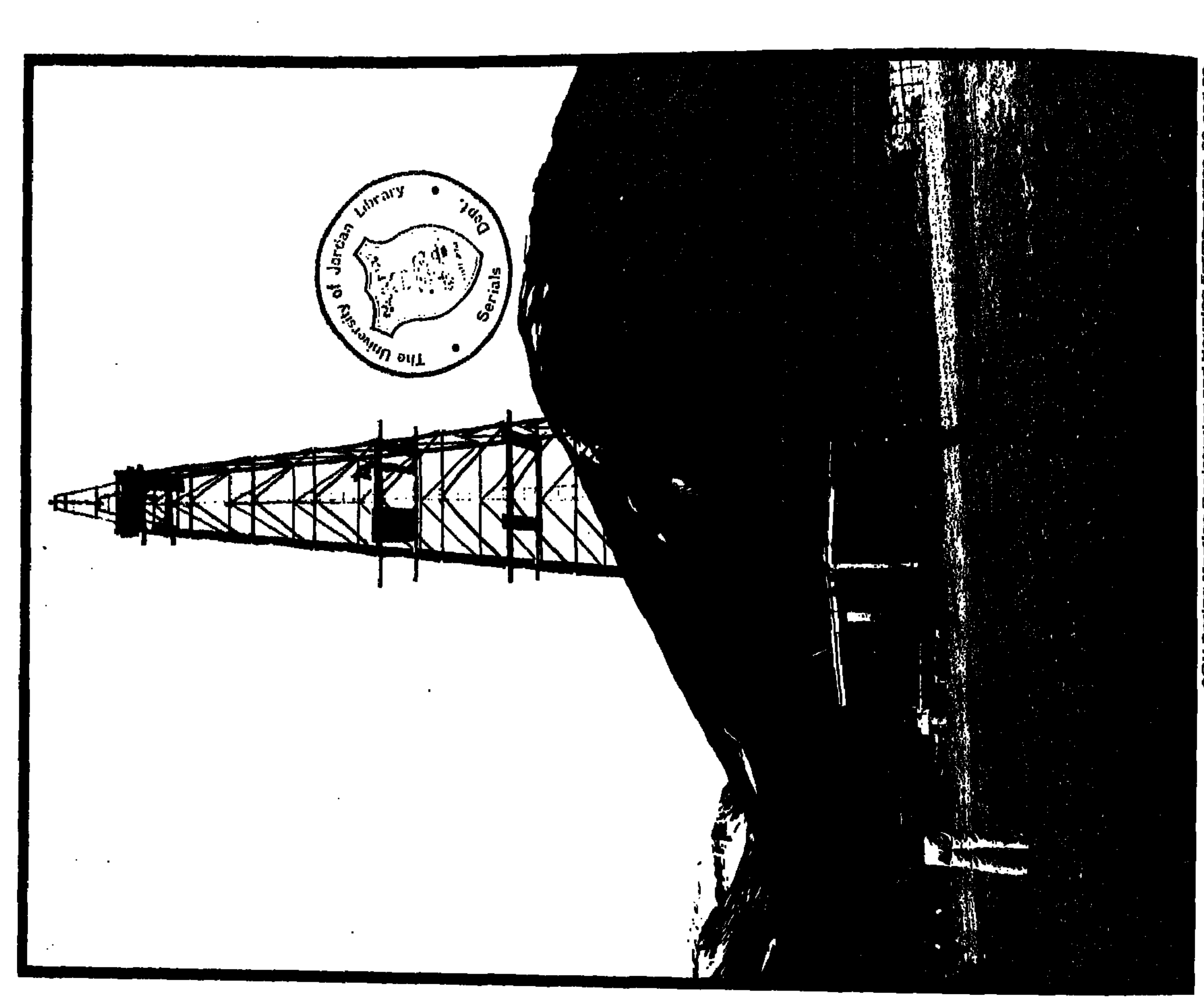

EOS. TRANSACTIONS, AMERICAN GEOPHYSICAL UNION VOL. 62, NO. 4, PAGES 33-40 JANUARY 27, 1981

Particles and Fields—Magnetosphere

5770 Short-period (less than 1 day) variations of magnetic field
FACTORS CONTROLLING THE OCCURRENCE OF Pc 3 MAGNETIC PULSATIONS AT SYNCHRONOUS ORBIT
K. Takahashi (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California 90024) R. L. McPherron, E. W. Greenstadt, and C. W. Arthur

The dependence of the occurrence probability of Pc 3 pulsations (frequency = 0.022–0.100 Hz) at synchronous orbit on factors such as local time and solar wind parameters is studied. Power spectra calculated from the magnetic field observed at the ATS 6 satellite for a one-year period from June 1974 to May 1975 were examined to identify Pc 3 pulsation occurrence. Pc 3 pulsations are usually observed in the dayside magnetosphere. The average diurnal occurrence pattern is a maximum at 0900 LT with the pattern shifting to earlier local times in winter and to later local times in summer. Solar wind velocity, V_{SW}, and the direction of the interplanetary magnetic field with respect to the sun-earth line, θ_{XB}, significantly affect the occurrence probability. Large V_{SW} and small θ_{XB} are favorable for the occurrence of Pc 3 pulsations. The average occurrence probability over 0600–1600 LT changes from 10% for V_{SW} < 400 km/sec and θ_{XB} > 60° to 80% for V_{SW} > 600 km/sec and θ_{XB} < 20°. The result suggests that the solar wind controls Pc 3 occurrence. However, the study of the occurrence probability alone is not sufficient to distinguish between the most likely sources, that is, the magnetosheath turbulence and the Kelvin-Helmholtz instability at the magnetopause. (Magnetic pulsation, Pc 3, solar wind).
J. Geophys. Res., Blue, Paper 1A0096

5775 Trapped particles
A COMPARISON OF THE RADIO DATA AND MODEL CALCULATIONS OF JUPITER'S SYNCHROTRON RADIATION; I. THE HIGH ENERGY ELECTRON DISTRIBUTION IN JUPITER'S INNER MAGNETOSPHERE
I. de Pater (Lunar & Planetary Laboratory, University of Arizona, Tucson, Arizona 85721)

An electron distribution in Jupiter's magnetosphere as a function of energy, pitch angle and spatial coordinates is derived from a comparison of model calculations of the planet's synchrotron radiation with the radio data; the distribution is consistent with the information available from the Pioneer data. The model calculations are based upon the magnetic field configurations as derived by Acuna and Ness (1976) (the O_4 model) and Davis, Jones and Smith (quoted in Smith and Gulkis, 1979) (the P_{11} (3,2)A model) from the Pioneer data. The electrons are assumed to diffuse radially inwards with a rate $D = 3 \times 10^{-9} L^3$ sec^{-1} (where L is McIlwain's value) and have a lifetime against local losses $\tau = 4 \times 10^6 L^{-0.6}$ sec, in agreement with the values derived by Goertz et al. (1979) from the Pioneer data. The number density of electrons with E ≥ 20 MeV at L = 3 is in agreement with the values measured by the spacecraft, but the energy distribution appears to be much flatter. Electrons are absorbed with survival probabilities of 0.5 diffusing inwardly past Amalthea's sweeping region (for 20 MeV electrons) and 0.35 past the ring, respectively. An energy dependent pitch angle scattering is found to occur at Amalthea's orbit, and there is no pitch angle scattering present near the ring. It appears that the "hot region" observed in Jupiter's radio emission cannot be fully explained with the electron distribution derived in this paper. In a forthcoming paper (...II) it will be shown that and how a change in the longitude distribution of the electrons can account for this "hot region". (Jupiter, synchrotron radiation, electron distribution).
J. Geophys. Res., Blue, Paper 1A0072

5775 Trapped particles
A COMPARISON OF RADIO DATA AND MODEL CALCULATIONS OF JUPITER'S SYNCHROTRON RADIATION: II. E-W ASYMMETRY IN THE RADIATION BELTS AS A FUNCTION OF JOVIAN LONGITUDE.
I. de Pater (Lunar and Planetary Lab, University of Arizona, Tucson, Arizona 85721)

Based upon a comparison of radio data with model calculations of Jupiter's synchrotron radiation we have shown that the "hot region" in the planet's radiation belts cannot be explained by the difference in beaming efficiencies between the left and right sides of the belt alone, which difference is due to the higher order moments in the O_4 and P_{11} field models. In addition we need to have an overabundance of electrons at jovicentric longitudes λ_J ~ 240°–360° and the existence of a dusk to dawn directed electric field over the inner magnetosphere. The presence of this field results in a relatively larger amount of radiation from this side (at longitudes 150°–300°) or partly compensate for it. (hot region, electric field, overabundance of electrons).
J. Geophys. Res., Blue, Paper 1A0074

Editorial

Poster Papers

In many scientific societies, presentation by poster has become a popular alternative to oral delivery for contributed papers at major meetings. This has not been so in the AGU. My purpose in this 'editorial' is to acquaint the AGU membership with some of the advantages of the poster paper as an occasional alternative to the 10-minute talk.

The main advantage for the author of a poster paper is the opportunity for interaction with an interested audience for a 3-hour period. Significant feedback from the audience is a bonus that gives the author a better understanding of his own work and how to explain it, both orally and in print. Those of us who have tried poster presentation have found it to be a very positive experience.

Certain topics naturally lend themselves to poster presentation rather than oral delivery. Tables of numerical results fall in this category, as do ideas that are too complicated to explain in 10 minutes. Authors have been tempted to gain extra speaking time by subterfuge, but the program committee will vigorously resist such tactics in the future. A possible alternative is for the leader of a research group to describe the concept in his 10-minute talk and refer the audience to poster papers by colleagues and students for details and applications.

Many individuals find poster presentation to be more effective than oral delivery, regardless of the subject, frankly because many individuals do not present good talks. I should emphasize that there is no intention to force anyone to present a poster paper rather than speak. The intention is to offer the poster option as a viable and voluntary alternative.

From the viewpoint of the program committee, a major advantage of poster sessions is that they accommodate more papers than oral sessions do. This enables us to reduce the number of parallel sessions that must be scheduled. It enables people to attend more papers (both oral and poster) of their choice and makes more time available for discussion after oral papers elsewhere in the program.

The major objections against poster sessions are largely theoretical. One objection is that a 3-hour stand at a poster is too strenuous for the author and causes him to miss papers at any parallel sessions. My suggestion would be for coauthors to share the duty by standing for 90 minutes each and for a sole author to post a notice specifying which 2 hours (out of the three) the poster will be attended. Those interested can read the poster in his absence and consult the author during posted hours. A second objection is that students and other newcomers to the field may remain unknown to their colleagues and inexperienced at public speaking if denied the captive-audience aspects of an oral session. My suggestion would be for such persons to consider poster presentation at every third meeting. The eventual goal is to have about 40% of the papers at SPR sessions presented as posters. It is not our goal to eliminate oral presentations, either contributed or invited. A third objection is that people perceive poster presentation as a second-class mode of expression. My response would be that people who have tried poster presentation do not find it so. People who still perceive poster presentation as second class need to have their perceptions changed. The AGU can facilitate this change by providing first-class facilities, e.g., bulletin boards and tables rather than cardboard and easels. The author can provide a sign-up sheet for preprint requests. What we really need is a 'critical mass' of abstracts designated by their authors for poster presentation, so that the AGU can justify the cost of poster facilities and so that the program committee can dedicate certain meeting rooms to poster presentations exclusively.

Our plan for the SPR sections at the Baltimore (1981 Spring) Meeting is to have special poster sessions on Birkeland currents (SA/SM) and on waves, instabilities, and turbulence in space plasmas (SM). Contributed poster papers on these topics are hereby solicited. The popularity of poster presentation in other societies is truly impressive. Fully 80% of all papers at the recent American Physical Society Division of Plasma Physics meeting in San Diego were poster papers. That may have been too much of a good thing. However, experience has shown that a reasonable proportion of poster papers is essential for the program committee, beneficial for the audience, and rewarding for the authors.

Michael Schulz
Secretary and Program Chairman
for Magnetospheric Physics

Circulation in the Coastal Ocean, Part 2

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This paper is the second of three parts to be published in Eos. *Part 1 appeared in the January 13 issue.*

Trapped Waves and Propagating Fronts

Some flow phenomena observed in the coastal ocean are clearly unrelated to the wind. One of the most spectacular is the apparently spontaneous reversal of a well-established *coastal current* set up previously by wind. Such reversals have been documented in detail in Lake Ontario, but they have also been noted in other locations. Current reversals, and other less drastic changes in the flow, are often found to propagate alongshore in one specific direction only, leaving the coast to the right. Thus in the Great Lakes, such 'signals' propagate cyclonically, or counterclockwise, around a basin, along the east coast of North America southwestward, along the west coast northward. For brevity, this direction will be called 'cyclonic' in all applications.

The basic dynamical principles that govern the propagation of the relevant types of trapped waves are as follows: The longshore component of the wind stress, which primarily generates longshore currents, is nonuniform over the scale of basin topography or weather systems. In the case of a closed basin, a uniform wind drives the coastal current in a cyclonic direction along some portion of the coast, in an anticyclonic direction along another portion (see Figure 3 in part 1, *Eos*, January 13). Similar, though less drastic, variations occur along continental oceanic coasts on account of changes in coastline orientation. In addition, the wind stress field varies on a scale of only a few hundred km sometimes, and it becomes an important factor in causing longshore current variations along a more-or-less straight coastline.

Where the wind stress, and the longshore current it generates, is directed anticyclonically, a sea-level depression develops as the longshore current adjusts to geostrophic equilibrium. A cyclonically directed coastal current is associated with a rise in coastal sea level. The nonuniformity of wind stress along the coast thus causes a longshore sea-level gradient to come into existence along the coast as a system of longshore currents develops. For a closed basin, this has already been illustrated in Figure 3 of part 1 (*Eos*, January 13). The longshore sea-level slope accelerates the coastal water in a 'downhill' direction, indicated by the broken lines. Thus, eventually, the originally downwind end acquires a cyclonic coastal current, the upwind end an anticyclonic one. As a result, the two stagnation points between cyclonic and anticyclonic coastal currents and the entire flow pattern shift, in a cyclonic sense. If only small displacements of the surface (and of the thermocline) are involved, the phenomenon may be viewed as a propagating wave.

The pressure changes associated with the geostrophic balance of the coastal currents originally set up by the wind are confined to a nearshore region, the width of which ('trapping width' of the currents and subsequent wave propagation: these waves are said to be 'trapped' at the coast) depends entirely on the coastal geometry in homogeneous water. When the water is stratified, the trapping width becomes the internal radius of deformation. An important point is that, in a stratified fluid, the nearshore isopycnal tilts associated with cyclonic and anticyclonic coastal jets are opposite, and the change from one to the other involves the replacement of a considerable coastal water mass by lighter or denser water drawn from offshore.

Simple theoretical models are the internal Kelvin wave and the shelf wave or topographic wave. The internal Kelvin wave is a classical, constant depth, two-layer fluid model that is discussed in standard texts. Trapped waves also arise in a homogeneous fluid on account of sloping topography. The low frequency, earth-rotation-dependent modes of these have properties much as discussed above, i.e., nearly geostrophic flow and modest propagation velocity. Topographic waves have been identified by *Reid* [1958] and used by *Robinson* [1964] for modeling the propagation of sea-level disturbances along the east coast of Australia. A considerable literature was generated on this topic, which was reviewed recently by *Mysak* [1980]. Figure 1 illustrates the structure of flow in a simple topographic wave model. In shallow seas both bottom slope and stratification are important in determining the structure of trapped waves, and the most important modes are hybrids between the internal Kelvin wave and the topographic wave in a homogeneous fluid.

Such simple theoretical models again suppose small displacements of the isopycnals from equilibrium and do not relate directly to situations involving, for example, the surface outcropping of the pycnocline. At present there is not much theoretical guidance to understanding the propagation of surface fronts. Consider, for example, the case illustrated in Figure 2, and which occurs frequently in the Great Lakes. The pycnocline intersects the free surface some distance offshore, along a finite portion of the coast only. The pycnocline-surface intersection meets the coast in two locations, more or less at a right angle. Over a substantial portion of the coast the surfaced pycnocline can move in a cross-shore direction without affecting coastal sea levels, so that presumably it is not involved in the propagation of sea-level disturbances. One would expect that in such locations disturbances would propagate more or less as a 'pure' topographic wave in homogeneous fluid, without interfering with the coastal jet flow structure that accompanies the surface pycnocline.

Where the surfaced pycnocline runs into the coast, however, geostrophic flow along the isopycnals is prevented by the coast and the sharp pressure gradients in the longshore direction (present in the surface layer on account of isopycnal slope) generate fluid particle velocities that affect the propagation of the front. *Yamagata* [1980] has recently proposed a simple theoretical model of the propagation of 'warm' fronts of this kind. As in the linear theory, such a front, e.g., the eastern end of the cold pool in Figure 2, propagates in a cyclonic direction around the basin. However, the propagation is slowed down by self-advection, i.e., by particle velocities opposing the direction of wave propagation.

Whether one regards a propagating, coastally trapped flow feature as a 'wave' or a 'front,' it should, according to theory, be accompanied by a pressure field which extends over a coastal region of limited 'trapping' width (typically 10–100 km) and which propagates in a cyclonic direction along the coasts of oceanic basins at a speed of 1 or 2 m/s; its principal signature should be strong longshore flow. As for directly wind-driven longshore currents, geostrophic balance implies a relationship between the coastal-sea-level signal and the longshore velocity amplitude. At mid-latitudes, this means that, given a narrow trapped field, say 10 km wide, a velocity amplitude of 0.1 m/s corresponds to a sea-level signal of 1 cm. A sea-level signal of this amplitude is small compared to short-term level fluctuations associated with tides, seiches, etc., and its detection is possible only through statistical time series analysis. By contrast, a velocity signal of 0.1 m/s is of the same order of magnitude as fluctuations that are due to other causes and is more immediately apparent in any record. Where the trapped wave is of the internal Kelvin wave type, isopycnal movements accompanying it are also large and conspicuous.

Current meter observations on the Oregon-Washington shelf in the early '70's provided direct and convincing evidence for the northward propagation of flow episodes that are unrelated to the wind [*Kundu and Allen*, 1976; *Allen and*

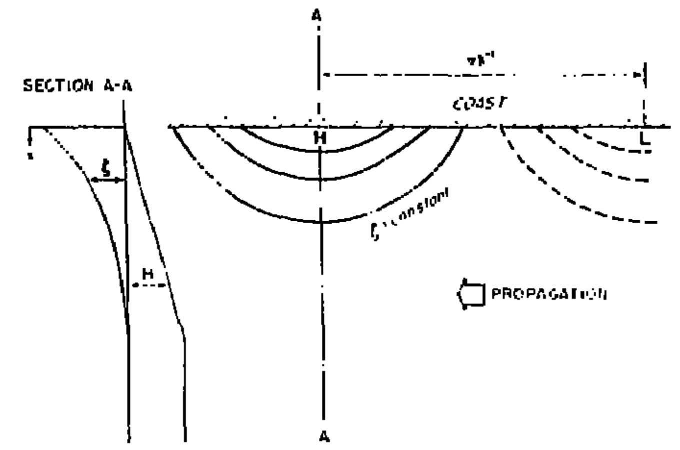

Fig. 1. Distribution of surface elevation ζ in idealized topographic wave model. The broken lines indicate surface depression. The section at left also shows assumed distribution of water depth. Wave disturbance is confined to a sloping portion of the coastal region; the direction of propagation is 'cyclonic,' i.e., leaves the coast to the right.

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Cover. Long-term velocities observed by fixed-point current meters at various locations and depths (given in meters on arrows) in the Mid-Atlantic Bight. Length of arrow gives magnitude of mean velocity (see scale on center right). (From *Beardsley et al.* [1976].)

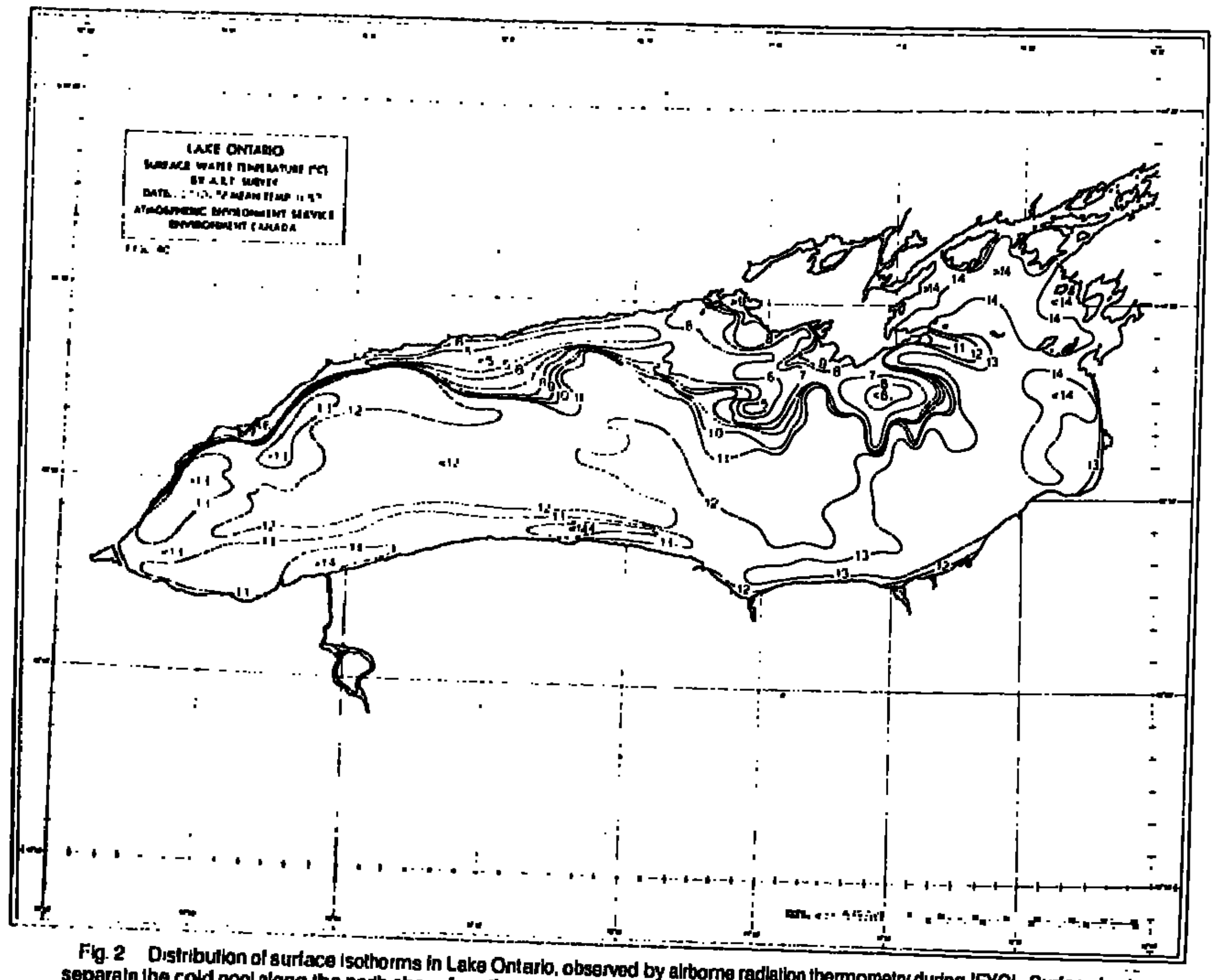

Fig. 2 Distribution of surface isotherms in Lake Ontario, observed by airborne radiation thermometry during IFYGL. Surface fronts separate the cold pool along the north shore from the rest of lake. The corresponding temperature distribution in a cross section of the coastal region was shown in Figure 7 of part 1 (*Eos*, January 13). Figure courtesy J. G. Irbe, Atmospheric Environment Service, Toronto (*from Csanady* [1977]).

Kundu, 1978]. Figure 3 shows a comparison of winds and currents observed at the central transect of the 1973 CUE-2 (Coastal Upwelling Experiment) experiment. One flow episode centered at July 31 is clearly not wind driven. Figure 4 shows the northward propagation of the same event over a distance of about 80 km at a speed between 100 and 150 km/day. Along the 100-m isobath, the current fluctuations involved the entire water column and were strong enough to reverse the direction of the flow for about a 2-day period. During the same period, the temperature at 40-m depth was higher by about 0.5°C than before or after, showing that substantial isopycnal adjustment accompanied the episode. Although the precise flow structure of the event is not clear from the data, it seems reasonable to regard it as a hybrid Kelvin-topographic wave with an offshore trapping scale of the order of 20 km. A detailed analysis of the velocity structure supports this notion.

Faster waves (300–500 km/day) have also been inferred to travel along the same shelf at other times. The trapping width of these should be somewhat greater, and they may be closer to a homogeneous fluid or 'pure' topographic wave in modal structure. The occurrence of different wavelike modes and their relative rarity, given the dominance of direct quasi-local forcing by weather systems of large horizontal extent, explains why the statistical time series analysis of sea-level fluctuations, or of longshore velocities, tends to be confusing.

The evidence for cyclonically propagating sea-level disturbances, warm and cold fronts, and current reversals is strongest and most detailed in the Great Lakes. The earliest clear demonstration of internal Kelvin wavelike propagation of a warm front around the southern end of Lake Michigan was given by *Mortimer* [1963]. More detailed evidence on the propagation of internal Kelvin waves was obtained in Lake Ontario during International Field Year on the Great Lakes (IFYGL). At the end of July 1972, a series of eastward wind-stress impulses generated a system of coastal jets associated with appropriate uptilts and downtilts of the thermocline. By the end of the wind stress episode of 4 days duration, the thermocline tilt and current direction were reversed at some coastal transects. At the end of a further 4 days of calm weather, the reversal propagated virtually around the entire lake. The offshore trapping width was clearly seen in the experimental data to be of order 5 km, as suggested by a two-layer linear model, and the propagation speed was a corresponding 0.5 m/s. The modal structure of the wave was close to a hybrid topographic-internal Kelvin wave.

At a speed of 0.5 m/s, a wave travels around the perimeter of Lake Ontario in about 15 days. *Blanton* [1975] examined current meter spectra from Lake Ontario and found pronounced periodicities at 12–14 days. In October 1972, on the north shore of Lake Ontario, an upwelling event was also documented by using airborne radiation thermometry (see Figure 2 above). The sequence of surface isotherm maps for the period following the development of the upwelling clearly shows the slow propagation of the warm front, which marks the eastern end of the upwelling zone, toward the west and a similar movement of the cold front at its western end toward the east (Figure 5). The speed of propagation appeared to be somewhat less than internal Kelvin wave speed.

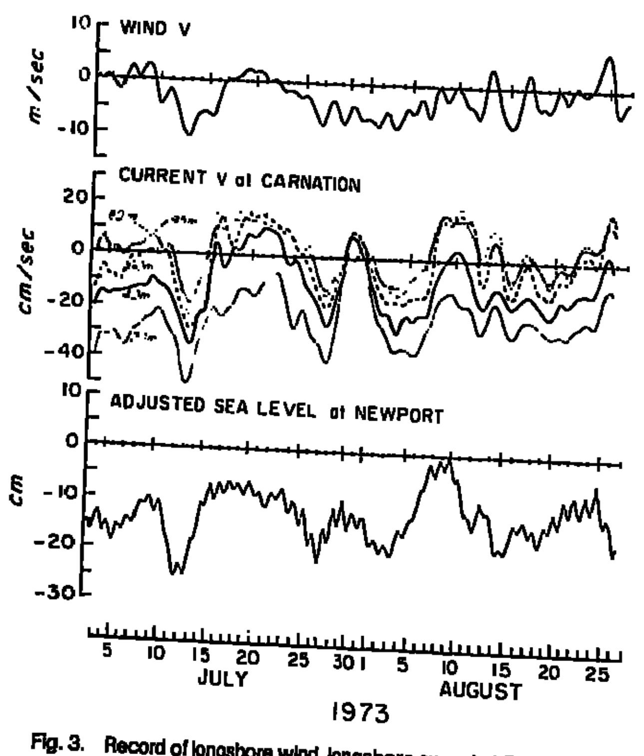

Fig. 3. Record of longshore wind, longshore current at five levels, and sea level at central transect of 1972 Coastal Upwelling Experiment (CUE) off Oregon. For most of the period, currents are directly wind driven, but an event centered on about July 30 is clearly unrelated to the local wind. (From *Allen and Kundu* [1978].)

Flow Controlled by Bottom Friction

Over continental shelves of the Atlantic type, tidal currents are generally strong, with the result that turbulence level is high and the adjustment time to frictional equilibrium is short. Under such circumstances, circulation is dominated by steady flow episodes in which forcing by the wind is generally opposed by bottom stress, although not always or everywhere, the pattern of flow being also strongly dependent on topography.

The simple model of a developing longshore current illustrated in Figure 2 of part 1 (*Eos*, January 13) did not take into account bottom friction. This is clearly unrealistic in very shallow water, where a substantial longshore transport could only develop if the velocity became very high. As the longshore velocity increases, so does bottom stress, until it balances the applied wind stress, or the longshore pressure gradient, if the latter is the driving force. The longshore current, and with it the transport, is thus limited in intensity by bottom friction. Important questions are, how large the limiting velocity and transport become, how long it takes for the flow to adjust to frictional equilibrium, and how the frictional adjustment time varies with depth.

Calculations based on a standard turbulent flow model, using a quadratic frictional drag formula, yield the estimate that, for a 'typical' wind stress of 0.1 Pa (accompanying a 7 m/s wind), the flow adjusts to frictional equilibrium in about 3 h in a 10-m-deep water column. The adjustment time varies directly with depth and inversely with wind speed. In a hurricane blowing over shallow water, frictional equilibrium is very rapidly established. The limiting velocity of longshore flow at which the applied stress becomes balanced by bottom friction is about 0.2 m/s under average winds (0.1 Pa) but reaches 2 m/s in a hurricane.

Where tidal motions at moderate to high velocities occur, the wind-driven component of circulation may for many purposes be regarded as a perturbation on the tides. The period of the semidiurnal tide is the minimum period for which a 'circulation' component of the flow can be usefully defined or observed in such an environment. The value of the frictional adjustment time equals the semidiurnal period in water about 60 m deep under average conditions and is much shorter in strong winds. Thus even under average conditions, a typical Atlantic-type shelf responds in the frictional mode to forces affecting its circulation. This is even more obviously the case in stronger winds.

A realistic idealization of many continental shelves is to suppose isobaths straight and parallel to the coast. As in the simplest transient cases, the cross-isobath transport may be supposed to vanish within some range of the coast ('coastal constraint'). These simple idealizations imply for steady flow that the longshore slope of sea level remains constant with distance from shore. The magnitude of the longshore gradient is arbitrary and is the only free parameter available to represent the local effect of the basinwide (global) circulation on a limited coastal region or, in other words, to match the along-isobath flow that is supposed to occupy a given coastal region to the flow outside.

For a variable depth water column, the force balance between a longshore pressure gradient constant with distance from shore, wind stress, and bottom stress is analogous to what was discussed above for transient flow in a closed basin, with 'setup' opposing the wind stress. Along an open coast, however, the pressure gradient need not oppose the local wind. Where the pressure gradient supports the wind in generating longshore flow in a given direction, bottom stress must be strong enough to balance both. If the two are in opposition, the bottom stress must make up the difference. In shallow water, the pressure gradient force that is proportional to depth is small, and bottom stress must always oppose wind stress. Where the depth is large enough for the pressure gradient force to overwhelm the wind stress, bottom stress opposes the pressure gradient force. Thus if wind stress and longshore pressure gradient are in opposition, bottom stress vanishes along a critical isobath and changes sign on crossing this isobath. This is analogous to the change of acceleration in the transient current developing along the same isobath.

In relatively deep water (compared to the Ekman-layer depth), the interior of the water column is unaffected by friction. Here the longshore sea-level slope drives cross-isobath geostrophic flow. As the depth varies, so does the geostrophic cross-shore mass transport. For longshore wind stress constant with distance from shore, the divergence of the geostrophic cross-shore transport is absorbed by a bottom Ekman layer. This is possible because the pressure-gradient-driven flow becomes stronger in deeper water and generates higher bottom stress and a thicker bottom Ekman layer, which is able to conduct away the excess geostrophic cross-shore transport (Figure 6).

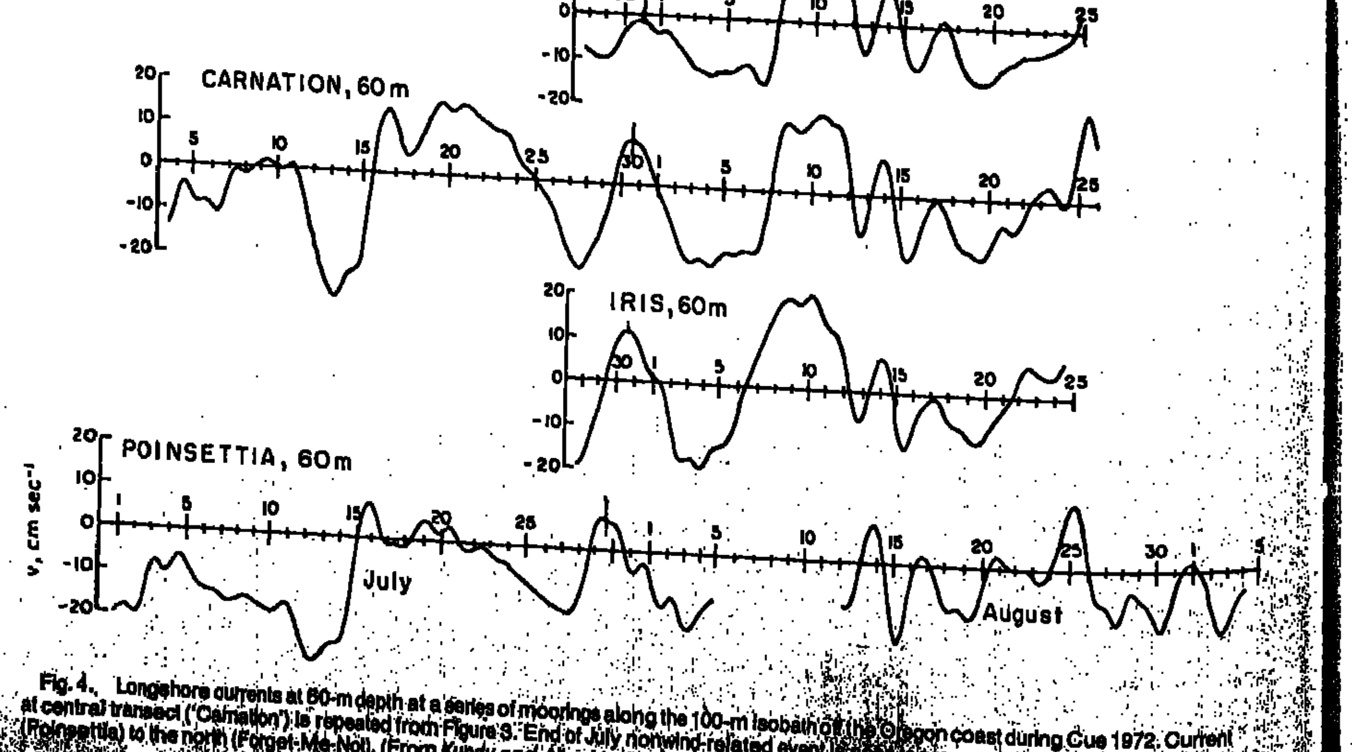

Fig. 4. Longshore currents at 60-m depth at a series of moorings along the 100-m isobath off the Oregon coast during Cue 1972. Current at central transect ('Carnation') is repeated from Figure 3. End of July nonwind-related event is seen to propagate from the south (Poinsettia) to the north (Forget-Me-Not). (From *Kundu and Allen* [1976].)

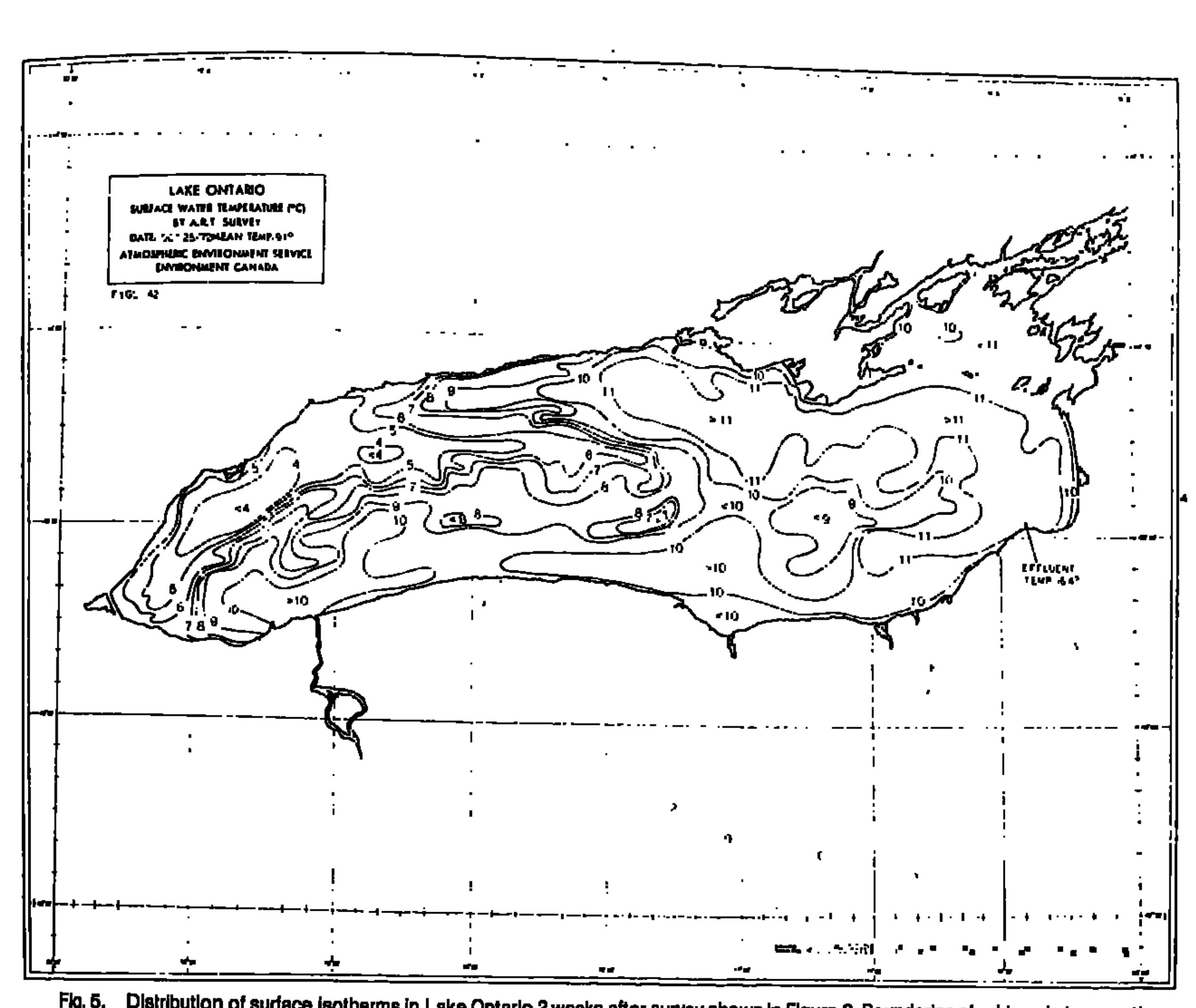

Fig. 5. Distribution of surface isotherms in Lake Ontario 2 weeks after survey shown in Figure 2. Boundaries of cold pool along north shore are seen to have propagated cyclonically around a significant fraction of the lake perimeter. (From *Csanady* [1977].)

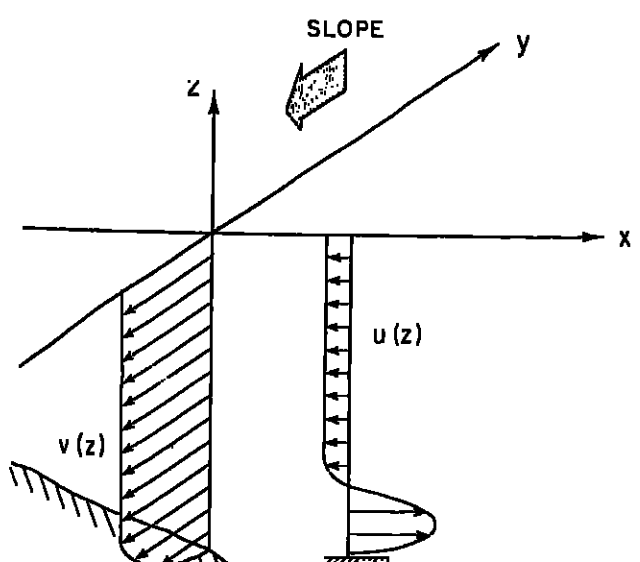

Fig. 6. Structure of flow driven by constant longshore pressure gradient ('slope') over continental shelf of variable depth. Distribution of longshore velocity $v(z)$ is similar to that in a laboratory channel, but it is accompanied by cross-shore flow $u(z)$, which is in geostrophic equilibrium with the longshore pressure gradient above a bottom frictional layer. The offshore Ekman transport in the latter balances onshore geostrophic flow (in the case illustrated) to satisfy the coastal constraint of zero cross-shore transport. Where the water is deeper, the same longshore pressure gradient drives more water shoreward, hence more must move seaward in the Ekman layer. This is possible only if the longshore bottom stress is greater, hence the water flows faster alongshore in deeper water.

Thermohaline Circulation

Although secondary in importance to the wind as a driving force, pressure differences within shallow seas also arise from horizontal density gradients caused by freshwater influx or rapid heating and cooling of shallow water. These may be expected to generate their own 'thermohaline' circulation pattern, which combines with wind-driven circulation. The observed southwestward drift of shelf waters off the east coast of North America (north of Cape Hatteras) has repeatedly been attributed to freshwater inflow. In the Great Lakes, rapid early season heating of nearshore waters leads to the formation of a so-called 'thermal bar' which is associated with a slow cyclonic circulation.

Similar effects may be understood in the simplest terms by considering a two-dimensional infinite coast model in which nearshore freshening or heating occurs uniformly along the coast. Although freshwater sources are concentrated in rivers, river plumes mix with shelf water within a relatively narrow coastal boundary layer, so that it is not too unreasonable to idealize the freshwater inflow as uniformly distributed along the shoreline.

A uniform line source of freshwater that mixes with seawater because of storm- and tide-induced turbulence should give rise to constant density surfaces parallel to the coastline. The typical winter salinity distribution in the Mid-Atlantic Bight, for example, is of this kind. Except near the shelf edge, there is little density variation at any location between top and bottom of the water column, but the horizontal density gradients are significant in generating pressure gradients in a cross-shore direction. Longshore density gradients are small over most of the shelf and may be neglected in a first approximation. Similarly, in the Great Lakes, early season heating leads to isothermal surfaces more or less parallel to the coast.

The pressure forces arising from such a density distribution accelerate the fluid in the first instance in an offshore direction at the surface, toward the shore near the bottom. If an imaginary vertical membrane that separates light nearshore fluid from heavier offshore fluid were withdrawn, cross-shore fluid motions would ensue until the Coriolis force deflected these into a longshore direction. The offshore-moving surface layers would develop cyclonic longshore velocity. The bottom layers, displaced shoreward, would acquire anticyclonic longshore motion. After adjustment to geostrophic equilibrium, the interface, originally at the imaginary membrane, would become tilted seaward at the surface, and sharp velocity differences would develop across the interface.

The density field associated with freshwater inflow or seasonal heating is relatively long-lived, and the transient behavior of a nearshore density front such as that just described should have little to do with the observed shape of such fronts. However, fronts of this type are unstable and subject to frequent breakdown, in the course of which they shed lenses of light fluid at the surface that move out into the heavy fluid and similar lenses of heavy fluid at the bottom that advance into light fluid along the bottom. Following breakdown of the front, geostrophic equilibrium is reestablished by inertia forces which restore a characteristic inclined frontal shape similar to what is generally observed at the edge of the shelf in the Mid-Atlantic Bight (Figure 7).

Why the constant property surfaces should be concentrated in a frontal zone at the edge of the shelf remains something of a puzzle at the present time. More nearly uniformly distributed density surfaces are sometimes also observed in the Mid-Atlantic Bight and other shallow seas. Whatever the details, cross-shore density gradients give rise to similarly directed pressure forces, and these are balanced by the Coriolis force of longshore flow. As may be expected, bottom friction reduces velocity near the bottom but leaves the cyclonically directed surface motion more nearly intact. Hence the general rule that thermohaline circulation that is due to freshwater inflow or nearshore heating is cyclonic. However, the intensity of such circulation is generally fairly low, surface thermohaline velocities being rarely as high as 0.1 m/s, except in frontal zones.

Winter Circulation in the Mid-Atlantic Bight

As already remarked, the circulation of the east coast shelf of North America north of Cape Hatteras, specifically that of the Mid-Atlantic Bight, is characterized by a persistent southwestward drift. On time-averaging data over periods of 1 month or longer, a clear and consistent pattern of longshore and cross-shore velocities emerges that is reasonably regarded as a steady state flow field and is compared with the simple frictional equilibrium flow models just described.

The observed winter circulation of the Mid-Atlantic Bight has the following characteristics:

1. In the middle of the water column, there is longshore (long isobath, more accurately) flow toward the southwest at an intensity of 3–10 cm/s, increasing noticeably with increasing distance from shore.
2. In the middle of the water column the flow is onshore (cross-isobath) over most of the water column at an amplitude of 1–3 cm/s.
3. Surface waters move to the southwest at mean speeds of 10–30 cm/s and in an offshore direction at 3–10 cm/s.
4. Bottom waters diverge at about the 60-m isobath, moving in an onshore direction at 0–3 cm/s in shallower water, offshore at similar speeds in deeper water.

A figure from *Beardsley et al.* [1976] shows a summary of some of the observational evidence obtained from fixed point current meters, which mostly determine velocities above a bottom frictional layer and below the surface Ekman layer. (See cover figure.) Other evidence, obtained mostly by Lagrangian tracers, has been summarized by *Bumpus* [1973].

The observed facts may be explained as being caused by four mean circulation components that are due to northeastward longshore wind stress, an opposing pressure gradient constant with distance from shore, offshore wind stress, and freshwater inflow, respectively. The interaction of longshore wind stress and opposing sea-level gradient is responsible for the increase of longshore velocity with distance from shore, according to the dynamical discussion above (see especially Figure 6). This also explains the divergence of the bottom boundary layer at a specific depth. The high offshore velocities at the surface result from the two wind-stress-related circulation components (caused by longshore and cross-shore wind, respectively) and from the thermohaline circulation.

Acknowledgments

This work has been supported by the Department of Energy under a contract entitled Coastal-Shelf Transport and Diffusion. A fuller, more quantitative version of essentially the same review will be published in 1981 in *Advances in Geophysics*.

References

Allen, J. S., and P. K. Kundu, On the momentum, vorticity, and mass balance of the Oregon shelf, *J. Phys. Oceanogr.*, *8*, 13–27, 1978.
Beardsley, R. C., W. C. Boicourt, and D. V. Hansen, Physical oceanography of the Middle Atlantic Bight, *Spec. Symp. Am. Soc. Limnol. Oceanogr. 2*, 20–34, 1976.
Blanton, J. O., Nearshore lake currents measured during upwelling and downwelling of the thermocline in Lake Ontario, *J. Phys. Oceanogr.*, *5*, 111–124, 1975.
Bumpus, D. F., A description of the circulation on the continental shelf of the east coast of the United States, in *Progress in Oceanography*, vol. 6, edited by B. A. Warren, pp. 111–159, Pergamon, New York, 1973.
Csanady, G. T., Intermittent 'full' upwelling in Lake Ontario, *J. Geophys. Res.*, *82*, 397–419, 1977.
Kundu, P. K., and J. S. Allen, Some three-dimensional characteristics of low-frequency current fluctuations near the Oregon coast, *J. Phys. Oceanogr.*, *6*, 181–199, 1976.
Mortimer, C. H., Frontiers in physical limnology with particular reference to long waves in rotating basins, *Proc. Conf. Great Lakes Res. 6*, 9–42, 1963.
Mysak, L. A., Topographically trapped waves, *Annu. Rev. Fluid Mech.*, *12*, 45–76, 1980.
Reid, R. O., Effect of Coriolis force on edge waves, 1, Investigation of the normal modes, *J. Mar. Res.*, *16*, 109–144, 1958.
Robinson, A. R., Continental shelf waves and the response of sea level to weather systems, *J. Geophys. Res.*, *69*, 367–368, 1964.
Walsh, J. J., T. E. Whitledge, F. W. Barvenik, C. D. Wirick, S. O. Howe, W. E. Esaias, and J. T. Scott, Wind events and food chain dynamics within the New York Bight, *Limnol. Oceanogr.*, *23*, 659–683, 1978.
Yamagata, T., On cyclonic propagation of a warm front in a bay of a northern hemisphere, *Tellus*, *32*, 73–76, 1980.

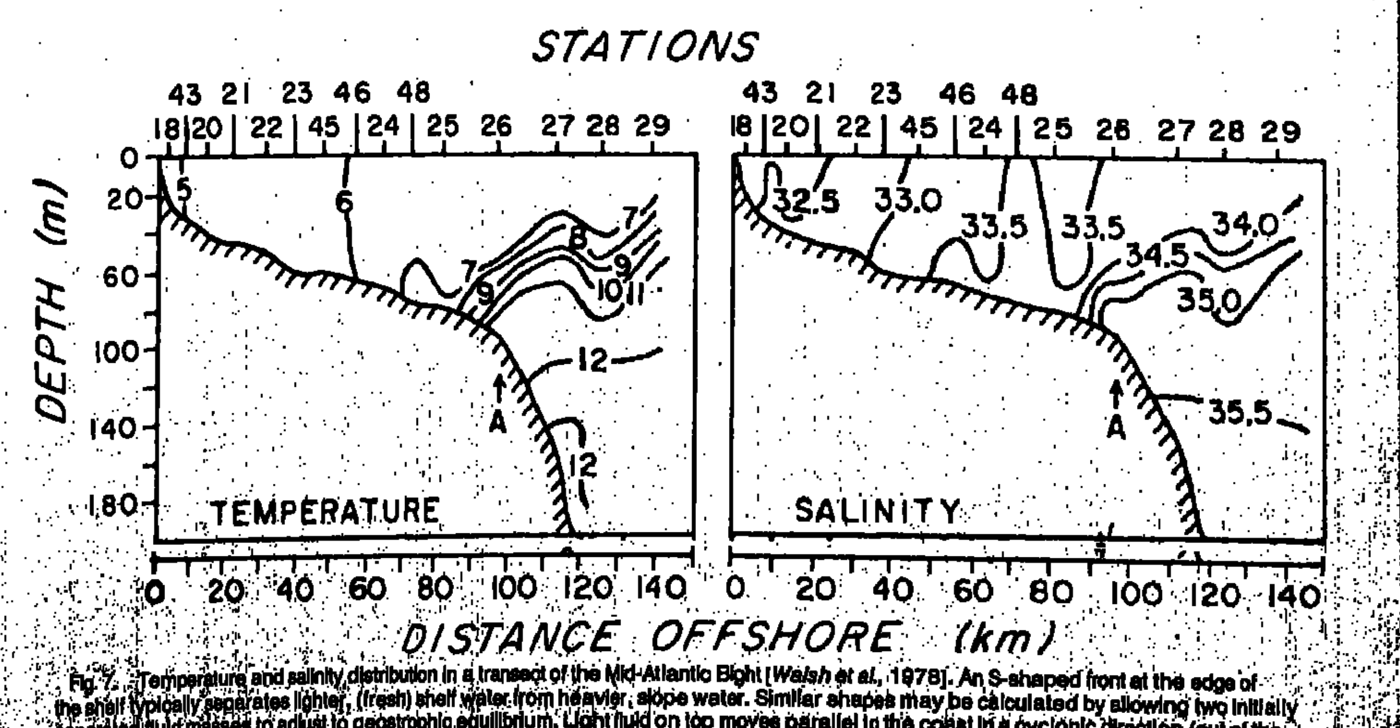

Fig. 7. Temperature and salinity distribution in a transect of the Mid-Atlantic Bight [*Walsh et al.*, 1978]. An S-shaped front at the edge of the shelf typically separates lighter, (fresh) shelf water from heavier, slope water. Similar shapes may be calculated by allowing two initially separated fluid masses to adjust to geostrophic equilibrium. Light fluid on top moves parallel to the coast in a cyclonic direction (out of the picture).

News

Ozone Measurement Device

A new instrument mounted on an aircraft has been used by the EPA to measure ozone concentration and distribution in a column of atmosphere for the first time. The instrument is called Ultra Violet Differential Absorption LIDAR (UV-DIAL). Previous instruments could give such data on ozone only in the area immediately surrounding the aircraft. LIDAR, light intensification detection and ranging, is similar to radar but uses electromagnetic waves of much shorter wavelength.

The new instrument uses light of two different wavelengths. One of the wavelengths is absorbed by ozone, and the other is not. The difference between the two combined signals is analyzed by the UV-DIAL to determine concentration and distribution of ozone in a column beneath the aircraft.

Air sampling is done simultaneously between the aircraft and the ground at 50-ft intervals. Since the system can measure both total amount of ozone and its distribution in the column, three-dimensional mapping of ozone can be obtained quickly and cheaply by flying the airplane in a criss-cross pattern. This provides information needed for modeling ozone's generation, movement, and transformation.

Conventional LIDAR has been used for years to detect particulate matter in the atmosphere. In these LIDAR systems an extremely short pulse of light is fired from the airplane toward the ground. It travels downward through the air at the speed of light and is then scattered back to the system in proportion to the amount of fine particulates in the atmosphere.

Future plans for UV-DIAL include increasing its daylight sensitivity by using a more powerful laser and developing a similar instrument to measure sulfur dioxide. The range is now limited during certain daylight hours because solar radiation also scatters light off atmosphere particulates.—*PMB*

Seabeam Echo Sounder

A Seabeam echo-sounder system, which produces a real-time contour map of the ocean floor from a moving ship, will be installed in the research vessel *Thomas Washington* during the fall of 1981. This will be the first such system installed in an American academic oceanographic ship. Acquisition and installation of the equipment was jointly supported by the Office of Naval Research (ONR) and by the Scripps Institution of Oceanography (SIO) with a grant from the Fleischman Foundation.

Use of the system is open to any investigator from any institution. A national scheduling advisory committee, appointed by ONR and SIO, held its first meeting at San Francisco, December 10, to establish the general areas of operation for the first 18 months of use. During this period the ship will work in the eastern north and equatorial Pacific, and the western North Atlantic, roughly between 15° S to 45° N, 30° W to 165° W. Proposals for work within this area should be sent to appropriate funding agencies (NSF, ONR, NOAA, DOE, et al.).

Information on costs, capabilities, and scheduling can be obtained from Ship Scheduling Office A-010, Scripps Institution of Oceanography, La Jolla, CA 92093 (phone 714/452-2840).

NASA To Begin Construction of Aviation-Safety Test Facility

Construction of a $7.5-million facility to research aviation safety will begin in April at NASA's Ames Research Center in Mountain View, California. Scheduled for completion in 1983, the facility will give scientists their first opportunity to identify and study psychological factors involved in the relationship between pilots, crew members, and modern aircraft.

The center will have two simulators. One will be a replica of a current transport airplane cockpit, complete with flight engineer's station, flight display, and control systems. The second will represent transport aircraft of the future. With advanced technology flight controls, displays, and other flight deck systems to accommodate a flight crew and observer, the advanced simulator will be designed to test human responses to the newest aviation technologies.

David Nagel, an aviation psychologist, and Rodger Hayes, project manager, are responsible for facility development.

Candidates for JGR-Blue Editor Sought

George L. Siscoe will complete his term as editor of the *Journal of Geophysical Research*—Blue at the end of 1981. A selection committee, chaired by Norman F. Ness, has been appointed to recommend candidates to the AGU president. Nominations for the editor for the space sciences section of JGR for the term 1982–1985 are now being accepted. Those who are interested in serving as editor, or who wish to suggest candidates, should send recommendations by April 15 directly to

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009
Attention: JGR Search Committee

Observatory Ends Scientific Investigations

The Orbiting Astronomical Observatory (OAO-3), which was instrumental in the discovery of the first suspected black hole, wound up its scientific investigation at the end of 1980. Spacecraft science operations were terminated after 8½ years of operation. Named Copernicus, OAO-3 performed consistently beyond design specifications and 7½ years beyond project requirements. Its performance profile, according to the NASA-Goddard engineers and scientists, was 'astonishing.'

While formal scientific investigations were ended December 31, a series of engineering tests are still being made until February 15. At that time, all contact with the spacecraft will end. Project engineers are uncertain whether Copernicus will orient itself permanently toward the sun, begin a permanent orbital tumbling action, or a variation of both.

Since its launch aboard an Atlas Centaur rocket August 21, 1972, from the Kennedy Space Center, Fla., the 2225-kg spacecraft has conducted its experiments from a 740-km-high orbit with a precision and clarity never before possible. Its supersensitive ultraviolet telescope, largest ever orbited, is capable of pointing accuracies equivalent to seeing a volleyball from a distance of 645 km. The 81-cm-diameter reflecting telescope provides data in the form of ultraviolet spectral readings otherwise invisible to ground-based observatories because of the obscuring effect of Earth's atmosphere. The instrument was built by Princeton University. Lyman Spitzer, Jr., is principal investigator.

University College, London, under sponsorship of the United Kingdom Science Research Council, provided the second instrument. It consists of three small telescopes and an associated counting device designed to study X-ray sources in space at various wavelengths. The experiment yielded important information on X ray sources, such as candidate black holes and neutron stars, and was instrumental in the discovery of the suspected black hole, Cygnus X-1.

Copernicus also produced information on star temperatures, gravities, and chemical composition. Additionally, it studied the atmosphere of Earth, Mars, Jupiter, Saturn, Titan, and Io. During its operation, Copernicus was used by more than 160 investigators from the United States and 13 foreign countries to observe more than 450 unique objects.—*PMB*

Mt. St. Helens' Eruption Potential Lower

The potential for a large explosive eruption of Mount St. Helens fell below potential in December, according to measurements made in mid-January by scientists at the U.S. Geological Survey and the University of Washington. Increased seismic activity beneath the volcano at the end of December had prompted the issuance of an advisory on December 27. In addition, the following day a new lava dome was first sited.

Prior to Christmas Day, two small earthquakes (less than 3 on the Richter scale) were recorded daily. Late Christmas Day, these events increased, reaching a maximum rate of four events per hour 2 days later.

A decline in seismic activity began on December 28; less than one earthquake was recorded per hour. This activity has continued to decrease to the background levels recorded during the noneruptive periods of this past summer and fall, according to the USGS.

In addition to the decline in seismic activity, since January 4 the emission rates of sulfur dioxide and carbon dioxide from the volcano's crater have been two thirds of the emission rates of December. Latest measurements are comparable to the average rates in November.

Fulbright Awards Available

The Council for International Exchange of Scholars still is accepting applications for geology lecturers for 1981–1982. Nominations already made are being processed; most scholars receiving awards will be notified in February or March, according to the Council.

Available positions include one volcanic ash soils lecturer, Argentina; seismic analysis and antiseismic construction, Ecuador; geological engineering, Turkey; and petrology and/or optical mineralogy, Uganda. In addition, several positions are available for a lecturer in Liberia. For additional information, contact the Council, Suite 300, 11 Dupont Circle, Washington, D.C. 20036.

Announcement of opportunities available to American scholars for 1982–1983 will be published by April.

New Publications

The Origin of the Southern Alps

R. I. Walcott and M. M. Cresswell (Eds.), *Bull. 18*, Royal Society of New Zealand, Wellington, 148 pp., 1979.

Reviewed by W. D. Means

Now that so many geologists have taken their plate tectonics pill and have recovered from the familiar seizure of enchantment or choking, a hopeful new era has begun in regional studies of young mountain belts. The central hope is that an accurate picture of orogenic movements for some Cenozoic belts can be reconstructed by fitting histories of local displacements consistent with on-land field studies to histories of the integrated displacements across entire belts inferred from marine magnetic anomalies and bathymetry. Therefore, special interest attaches to those relatively few places on earth where the marine features and the rocks on land are both well displayed and not too complicated. One such place is the South Island of New Zealand. It offers (1) a position astride the Indian-Pacific plate boundary, with continental crust both sides; (2) a relatively narrow zone (~200 km) through which most or maybe all of the interplate deformation is distributed; (3) a large component of recent shortening normal to the plate boundary, with associated large uplift of the glacier-hung Southern Alps and consequent good exposure; (4) a nearby seafloor triple junction around which a complete set of Cenozoic magnetic anomalies is preserved, such that long distance, multiplate calculations are not needed for the plate tectonics; and, of course, (5) the famous Alpine Fault.

Bulletin 18 of the Royal Society of New Zealand, *The Origin of the Southern Alps*, takes stock of the Cenozoic tectonics of the South Island as understood late in 1978, following a meeting of the authors in May of that year convened by the New Zealand National Committee for Geodynamics. There are 17 short papers, all containing new data and ideas and nearly all by workers based in New Zealand. A wide range of land-based geological and geophysical investigations is described. A helpful editorial introduction mentions some other recent and relevant work, to which I would add *Molnar et al.* [1975] (*Geophys. J., 40,* 383–420), who give a plate tectonic interpretation of the seafloor data, and *Walcott* [1978] (*Geophys. J., 52,* 137–164), who reviews late Cenozoic tectonics for the whole of New Zealand.

The papers discuss many questions of interest to workers outside New Zealand, among them: How are the interplate (horizontal) displacements distributed spatially, now and over the past few tens of millions of years? What is the partitioning of deformation between narrow zones of large displacement and velocity gradients (faults, shear zones, transposition zones, etc.) and broader areas of much smaller gradients? What is the history of uplift, its present rate, and its relationship to the horizontal movements? What is the three-dimensional configuration of the Alpine Fault and the reason for its apparent low seismicity? When did dextral movements start on the fault, and how are these related to the dextral 'oroclinal bend' in the previously deformed pre-Cretaceous rocks? Some salient features have emerged, such as the fact that the Alpine Fault itself is currently taking up only about a third of the interplate velocity (Walcott) with the Southern Alps somehow taking up the other two thirds. Uplift rates are currently high, of the order of a centimeter a year along the crest of the range (Wellman). The locus of most rapid uplift lies offset some kilometers to the east of the surface trace of the Alpine Fault (Wellman, J. Adams, C. J. D. Adams). A total Cenozoic uplift of 5–10 km has occurred since late Miocene time (C. J. D. Adams). The mountains are hot, with temperatures of several hundred degrees predicted within 2 km of the surface (Allis, Henley, and Carman). Despite progress on many fronts, the authors would probably agree that *Bulletin 18* only scratches the surface of what can eventually be learned about the answers to the basic questions. Some of the present interpretations differ from one paper to the next, like Wellman's idea that the Alpine Fault flattens eastward and becomes horizontal at 30 km versus Woodward's suggestion that the fault extends in some form down to 50 km without great change in a moderately steep, easterly dip. I found the whole volume absorbing. I liked Walcott's brave attempt to draw shear strain-rate profiles across the Southern Alps, based on meager retriangulation data and the plate velocity constraint, and Norris's even more daring effort to unstrain a large part of the South Island by using a grid of old fault traces as markers. Both made their assumptions clear. I liked J. Adams' measurement, using millimetric fault steps on the glacially polished surface of a schist outcrop, of very recent vertical motion near the Alpine Fault. I savored Wellman's conception that a listric east-dipping Alpine Fault, up which the Southern Alps are pushed, is paired with a deep west-dipping 'anti-fault' that carries the lower lithosphere back down beneath the mountains. *Bulletin 18* is full of innovations. Even the publisher has a go. There are tables of data interspersed in one of the reference lists, a case of figure captions transposed between two papers, and one entirely blank page in the middle of a paper. These novelties and the glaring misprints in many papers make one wonder whether the authors ever saw proofs. Never mind. *Bulletin 18* makes enjoyable reading in more ways than one. I recommend it to all tectonicians.

W. D. Means is with the Department of Geological Sciences, State University of New York at Albany, Albany, New York.

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Glaciologist/University of Washington. The University of Washington seeks applications for a tenure track position with the individual to be appointed as assistant professor jointly in the Department of Atmospheric Sciences and Geophysics program. Principal research interest of candidates should be directed toward geophysical or climate related study of snow or ice. Candidates specializing in physical processes in snow are of particular, but not exclusive, interest. All applicants should be committed to graduate level teaching, research advising, and innovative research emphasizing advanced experimental methods and rigorous physical analysis. Duties will include teaching one or two undergraduate courses per year in atmospheric sciences. The appointment starts in September 1981. A Ph.D. is required. For additional information call C. F. Raymond (206) 543-4914. Interested persons may send a resume and four letters of recommendation to Professor R. T. Merrill, Geophysics Program AK-50, University of Washington, Seattle, WA 98195.

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Dr. Derek W. Spencer
(Chairman of the Search Committee)
Box 54P

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Outstanding research ability is the most essential qualification. Teaching ability, including the supervision of graduate research students, is also an important requirement.

Candidates should send a resume with bibliography and a summary of research interests and experience to:

Professor Yervant Terzian
Chairman, Department of Astronomy
Space Sciences Building
Cornell University
Ithaca, NY 14853

Candidates should also arrange for three letters of recommendation to be sent to the above address. All application materials must be received by April 30, 1981.

Cornell University is an equal opportunity/affirmative action employer.

Faculty Appointment/Colorado State University. The Department of Earth Resources, Colorado State University invites applications for a tenure track appointment with emphasis on active research experience in remote sensing, and an interest in teaching graduate and undergraduate students beginning September 1981. The candidate is expected to have a Ph.D. degree in geology, watershed sciences or in a related field and is expected to develop and maintain a vigorous research program with special emphasis on the application of state-of-the-art remote sensing techniques to the investigation of natural resource phenomena. The candidate is expected to teach undergraduate and graduate courses in the application of remote sensing to natural resources.

Rank and salary are open and dependent on experience and qualifications of the applicant.

Applicants are invited to submit curriculum vitae, three letters of reference and a letter describing research and teaching interests to Dr. H. S. Boyne, Department of Earth Resources, Colorado State University, Fort Collins, Colorado 80523/(303) 491-5298.

Deadline for receipt of applications is April 15, 1981.

CSU is an EOE/AA. E.O. Office: 314 Student Serv. Bldg.

Environmental Resources Engineering/Humboldt State University. One or two probationary, tenure track, undergraduate faculty positions are anticipated for fall 1981. The first position requires expertise in geotechnical engineering with specialization in soil mechanics. Capabilities in sediment transport and/or structural mechanics are also desirable. The second position requires expertise in water quality, water resources, energy resources or related area. Special consideration will be given to applicants with field experience and the ability to participate actively in existing teaching and research programs. A doctorate in engineering or closely allied field is required. Forward résumé plus the names of three references by March 1, 1981, to C. M. Anderson, Chairman, Department of Environmental Resources Engineering, Humboldt State University, Arcata, CA 95521.

The University is an equal opportunity employer.

Meteorologist. Sigma Data Computing Corp.'s Division of Information and Scientific Applications invites applications from meteorologists qualified to participate in an environmental modeling/chemical fate assessment team effort.

The applicant will evaluate atmospheric models and their data requirements to form a comprehensive multimedia modeling library system for assessment of toxic chemicals. The applicant will also provide recommendations for modification of existing model algorithms and R&D for anticipated continuing model development.

An M.S. degree or equivalent experience is a minimum requirement. Programming experience in FORTRAN and use or development of air quality models is desirable but not essential.

Salary is commensurate with qualifications.
Please submit résumé and references to:

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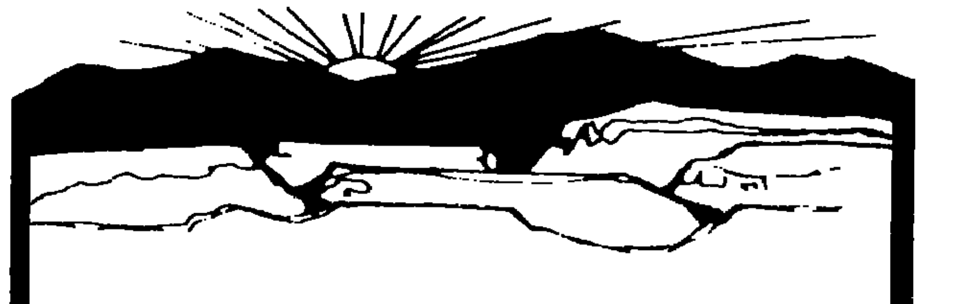

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Distinguished scientist with demonstrated administrative record sought to head a new branch of the University of California's Institute of Geophysics and Planetary Physics (IGPP) that has recently been established at the Los Alamos National Laboratory, Los Alamos, New Mexico.

This fourth branch of IGPP needs a leader to build a program suitable for Los Alamos and the remainder of the University of California. The successful applicant will serve both as Assistant Director of the Los Alamos National Laboratory reporting to the Director and as an Assistant Director of IGPP. The Assistant Director will be responsible for the coordination with the remainder of the University of California through the Director of Systemwide IGPP, O. L. Anderson.

REQUIREMENTS: Extensive research experience in a field related to the geosciences, an extensive publication record, proven managerial ability within a scientific organization, excellent communication skills, a Ph.D. or equivalent experience in Earth Sciences, Physics, or Chemistry.

Respond to Dr. Donald M. Kerr, Director, Los Alamos National Laboratory, DIV 81-AF, Los Alamos, New Mexico, 87545. Applications must be received by March 31, 1981.

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Assistant Professor/Civil Engineering. The University of Mississippi invites applications for a position of assistant professor in civil engineering beginning in August, 1981. The Department has an engineering science-oriented ABET accredited undergraduate program and ongoing graduate programs in the areas of soil mechanics, fluid mechanics, hydrology, and sedimentation engineering. Applicants should have a Ph.D. in civil engineering or some closely related field with a specialty in one or more of the fields mentioned above. Duties include teaching and research. Salary commensurate with experience. Apply by April 15, 1981, or until position is filled, to: Dr. Samuel L. DeLeeuw, Department of Civil Engineering, University of Mississippi, University, MS 38677.

Equal opportunity employer.

Von Braun Post-Doctoral Fellowship in Space Physics/University of Alabama in Huntsville. Appointment effective September 1981 in a tenure track assistant professorship with reduced teaching load during the first two years. Research specialty in astrophysics, planetary science or solar terrestrial physics. Research support available from UAH, NASA and Redstone Arsenal. Salary competitive. Recent Ph.D.s are invited to send résumé, research plans and names of four references. Apply to: Von Braun Fellowship Committee, Office of Academic Affairs, University of Alabama in Huntsville, AL 35899.

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Professor Donald R. F. Harleman
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Structural Geologist. The Department of Geosciences of Purdue University invites application for a tenure track faculty position in structural geology, starting in August 1981. Rank and salary will be commensurate with qualifications. A Ph.D. is required. The individual will be expected to teach undergraduate and graduate courses in structural geology and tectonics, participate in summer field courses, and pursue an active research program. Preference will be given to a candidate with an applied field orientation and a strong background in the quantitative analysis of field data. The department has active programs in petrology, geophysics, and engineering geology and has a close working relationship with the geotechnical group in civil engineering and the Laboratory for Applications of Remote Sensing. Closing date for application is April 1, 1981. Applicants should send a resume, the names, addresses, and telephone numbers of three referees, and a brief statement of research interests to R. H. McCallister, Department of Geosciences, Purdue University, West Lafayette, IN 47907.

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Stable Isotope Geochemistry/University of Saskatchewan. The Department of Geological Sciences has a vacant tenure track position at the assistant professor level for a stable isotope geochemist. Applicants should hold (or be about to receive) the Ph.D. degree, be qualified to instruct undergraduates in general geology and undergraduates and post graduates in geochemistry and petrology, be prepared to pursue a vigorous research program, and to assume control of a geochemistry research laboratory with Micromass 902 Double Collecting Mass Spectrometer. Letters of application, with curriculum vitae including the names of at least three referees, should be sent to W. G. E. Caldwell, Head, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Canada, S7N 0W0.

Geophysicist. The Geology Department at the University of Southwestern Louisiana in Lafayette, Louisiana invites applications for an anticipated research/teaching opening in geophysics. Responsibilities will include one-half time in seismic investigation of geopressured-geothermal reservoirs of South Louisiana and one-half time teaching geophysics and supervising graduate students. The successful applicant will be familiar with exploration seismic data acquisition, processing, and interpretation. The Ph.D. or Masters with experience, is required. Salary range is $23,000 to $35,000 per 12 month.

The position is expected to be filled in the Spring of 1981 or as soon as possible thereafter.

To apply please direct a resume, three letters of recommendation, and any other pertinent materials to Dr. Gary L. Kinsland, Geology Department, University of Southwestern Louisiana, Lafayette, LA 70504.

Stable Isotope Geochemist/University of Minnesota. The Department of Geology and Geophysics is seeking applications for a tenure track, assistant professor position for the academic year 1981 in the general field of stable isotope geochemistry. Applicants must have a Ph.D. degree by the time of appointment. The successful candidate will be aided in establishing a laboratory facility, is expected to pursue independent research, and teach appropriate undergraduate and graduate courses. Existing faculty have active research programs in the isotopic systematics of Sm/Nd, Rb-Sr, REE, Noble Gases and U, Th and their decay products; and productive interactions are possible between the new position and one or more ongoing programs in geo- and cosmochemistry, geo- and cosmochronology, economic geology, paleoclimatology, paleoecology, sedimentology, hydrology, mineralogy, petrology, geophysics, etc.

The previously advertised search has been extended until March 15, 1981.

Send curriculum vita, relevant reprints, research interests, and letters from three referees to:

E. Calvin Alexander, Jr.
Department of Geology and Geophysics
University of Minnesota
310 Pillsbury Drive S.E.
Minneapolis, MN 55455

The University of Minnesota is an equal opportunity educator and employer and specifically invites and encourages applications from women and minorities.

Acadia University. The Department of Geology, Acadia University, is seeking a head, beginning July 1, 1981. Preference will be given to applicants with experience and research interests in petroleum geology and related fields and/or energy resources. Rank and salary will be appropriate to qualifications. The successful candidate will assume leadership of an established, vigorous and growing department with five faculty members, and over 100 B.Sc. and M.Sc. candidates. Responsibilities include teaching at undergraduate and graduate levels, and academic planning and development in the specialty area.

A letter of application together with a curriculum vitae and names of three referees should be sent by March 15, 1981 to Dr. Earnest E. Zinck, Dean of Science, Acadia University, Wolfville, N.S., B0P 1X0.

Faculty Positions/University of New Orleans. The Physics Department of the University of New Orleans invites applications for two tenure track positions expected to be available August 1981. Rank and salary are to be commensurate with experience and training. The department has a policy of encouraging research activities in applied areas which are of mutual interest to the faculty and the local technical community. Candidates with background in computational physics, acoustics, and geophysics are especially encouraged to apply. Current research activities within the department include experimental atomic and molecular physics, solid state physics, cryogenic geophysics, hydrodynamics, and computational physics.

Applicants should send a resume to Edward L. Beeson, Chairman, Physics Department, University of New Orleans, LA 70122.

The University is an equal opportunity affirmative action employer.

Faculty Positions in Geology/University of Alabama. The Department of Earth Science is seeking applicants for a tenure track position at the assistant professor level. The Ph.D. degree is required. The selected person will teach one or more courses in geophysics at the undergraduate level, basic courses in earth science, will supervise senior independent research projects, will develop one or more elective courses in that person's specialty, and will develop a research program.

The Department of Earth Science consists of four full-time faculty and graduates approximately ten seniors each year. Equipment and facilities include a geochemical and sedimentation laboratory, rock preparation equipment, student and research petrographic equipment, Bison seismographic equipment, transit and alidade, drafting facilities, and computer equipment. Salary is competitive and commensurate with experience and education.

Applicants should send a resume, three letters of reference, and a brief discussion of research interests to Michael J. Neilson, Earth Science Department, University of Alabama in Birmingham, Birmingham, Ala. 35294, prior to May 1, 1981. The position will be available September, 1981.

The University of Alabama in Birmingham is an equal opportunity/affirmative action employer.

Drexel University/Atmospheric Scientist. Three tenure track faculty positions are anticipated starting fall 1981. Applications are solicited from Ph.D.s with independent research experience in one of the following areas of atmospheric science: general circulation; climate dynamics with application in satellite meteorology; atmospheric optics, experimental or theoretical with emphasis in mesoscale probing; boundary layer turbulence modeling and atmospheric chemistry modeling. Rank and salary commensurate with experience. Send resume and references to Dr. William W. Eidson, Head, Department of Physics and Atmospheric Science, Drexel University, Philadelphia, PA 19104.

An equal opportunity/affirmative action employer.

Postdoctoral Research Associate/Mineralogy. Applications are invited for research in high-resolution and analytical transmission electron microscopy of minerals and their analogues. Experience in crystallography, materials sciences, or electron microscopy is desirable. Send resumé (including transcripts), statement of research interests, and names of three references to P. R. Buseck, Department of Geology, Arizona State University, Tempe, AZ 85281.

Arizona State University is an EO/AA employer.

Sedimentary or Low Temperature Geochemist. This is an assistant professor, tenure track position, although exceptional candidates of higher rank will be considered. We are looking for a geochemist to complement our strong programs in sedimentology, hydrogeology, organic geochemistry, and basin analysis. The teaching load is three courses per year—one beginning level geology course, an upper level geochemistry course, and a graduate course of his/her choosing. Introductory geology and summer field camp are also taught on a long-term rotating basis. A well-equipped laboratory and computer facilities are available. The potential exists both for outside funding and for cooperative research.

The successful candidate will be expected to conduct an active research program leading to publications. Applicants should submit a letter of application, resume, a copy of each transcript, and have three supporting letters sent to:

Chairman
Department of Geology
University of Missouri
Columbia, Missouri 65211

The University of Missouri is an equal employment opportunity employer.

Postdoctoral Research Associate. Oceanography Department of the Naval Postgraduate School seeks recent graduate to study the hydrodynamics, through numerical ocean modelling of the physical oceanographic processes active in the vicinity of the arctic ice edge off Alaska. Problem areas include the effects of the complex bathymetry on the circulation and frontal formation, the dynamics associated with interleaving of water masses at the ice edge, and the mechanisms involved in ice retreat. Research will be performed in the context of an observational program which has acquired data and developed insights over the course of several years.

Position is available March 1981 and is renewable annually. Salary depends upon qualifications. Send resume and the names and addresses of three references to Faculty Search Committee, Dept. of Oceanography, Naval Postgraduate School, Monterey, CA 93940.

Equal opportunity/affirmative action employer.

Program Manager/Meteorology. Oceanographic Services, Inc., is seeking qualified applicants for the position of program manager for meteorological studies. Applicants should have an M.S. or Ph.D. in meteorology or atmospheric sciences, plus experience in the field. A broad general knowledge of air pollution, and an understanding of the air pollution regulatory environment, is helpful. Interested persons should send resume, references, and salary history to R. C. Banks, Oceanographic Services, Inc., 25 Castilian Drive, Goleta, CA 93117.

Remote Sensing/Ocean Engineering or Oceanography Faculty Position. Applications are solicited for two permanent nine-month positions involving both research and graduate and undergraduate teaching. Ability to initiate funded research is desirable. Send resume, brief statement of research areas, and the names of three references to F. W. Morris, Search Committee, Department of Oceanography and Ocean Engineering, Melbourne, FL 32901.

Equal Opportunity Employer.

Research and Data Systems, Inc./Scientific Programmers and Programmer Analysts. Immediate openings for persons with B.S. in science or math and at least two years experience with FORTRAN or PL1 on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 9420 Annapolis Road, Lanham, MD 20801. Telephone: (301) 459-0001.

Assistant Research Professor. A non-tenure track position in geological sciences at the University of Washington for a person qualified to run an active research program in ^{14}C dating. Experience with thermal diffusion ^{14}C enrichment technique, and knowledge of the application of Van de Graaff accelerators to ultra-high sensitivity ^{14}C mass spectrometry essential. Salary: $17,000–$21,000. Curriculum vitae, including two references to be sent by February 15 to M. Stuiver, Search Committee, Department of Geological Sciences, AJ-20, University of Washington, Seattle, WA 98195.

The University of Washington is an Affirmative Action/Equal Opportunity Employer.

Oceanographic Mooring Technician. The Marine Science Program at North Carolina State University (Raleigh) is expanding its oceanographic technical services group and is currently seeking a technician familiar with the design and deployment of deep-sea current meter mooring arrays, as well as with standard shipboard oceanographic sampling techniques.

Qualifications include a degree in science or engineering with some electronics background and two years field experience or an equivalent combination of education and experience. Salary commensurate with education and experience. Send resume and names of references to Personnel Services, North Carolina State University, P.O. Box 5067, Raleigh, NC, 27650.

An equal opportunity employer.

Geochemistry/Brittle Deformation, University of New Brunswick. The Department of Geology has a tenure track position available from July 1, 1981 at assistant professor or higher level. The successful applicant will be expected to teach both undergraduates and graduates as well as carrying out research and supervising graduate students.

Applications will be accepted in the following fields: geochemistry of ore bodies, exploration, environmental or soil geochemistry, brittle deformation, rock mechanics or site engineering.

Applicants should have a Ph.D. and preferably, post doctoral experience. Applications including a curriculum vitae and names of three referees should be sent to P. F. Williams, Chairman, Department of Geology, University of New Brunswick, Fredericton, N.B. E3B 5A3.

Virginia Polytechnic Institute and State University. Igneous Petrology and Geochemistry/Research Associate. Origin and tectonic significance of granitic rocks. Project involves petrography, analytic chemistry, mineral chemistry, isotopic studies, and field mapping. Send résumés to:

D. R. Wones, Chairman
Department of Geological Sciences
Virginia Poly. Inst. and St. Univ.
Blacksburg, VA 24061

The University is an equal opportunity/affirmative action employer.

Hydrologist. Sigma Data Computing Corp.'s Division of Information and Scientific Applications invites applications from hydrologists qualified to participate in an environmental modeling/chemical fate assessment team effort.

The applicant will evaluate terrestrial and groundwater models and their data requirements to form a comprehensive multimedia modeling library system for assessment of toxic chemicals. The applicant will also provide recommendations for modification of existing model algorithms and R&D for anticipated continuing model development.

An M.S. degree or equivalent experience is a minimum requirement. Programming experience in FORTRAN and use or development of water quality models is desirable but not essential.

Salary is commensurate with qualifications. Please submit resume and references to:

Roger Long
Sigma Data Computing Corp.
2021 K Street, NW
Suite 207
Washington, D.C. 20006

Physical Oceanographer/ Geophysical Fluid Dynamicist

Areté Associates, a growing research firm, located in Southern California, engaged in theoretical and empirical physical oceanography, is offering permanent, full-time positions. Candidates require Ph.D. (or equivalent experience) in physical oceanography or geophysical fluid dynamics. Salaries are competitive and negotiable, based on qualifications. Areté offers a fringe benefit package of superior quality. Qualified candidates should send résumé, salary history, and list of professional references to:

Personnel Administrator
Areté Associates
P.O. Box 350
Encino, CA 91316

An equal opportunity employer M/F.

Research Assistants/Utah State University. Exciting opportunities at the frontiers of knowledge exist for graduate and undergraduate research assistants in the Department of Electrical Engineering at Utah State University. USU, located at the base of the Wasatch Mountains, is engaged in ground-breaking investigations in many critical fields. Get involved in environmental sensing, digital electronics, microprocessor applications, electro-optics, or computer engineering. Do space and atmospheric physics with state-of-the-art instrumentation on the ground, in rockets, or aboard the space shuttle. For details on these and other projects, contact Doran J. Baker, Head, Department of Electrical Engineering, UMC 41E, Utah State University, Logan, UT 84332 (telephone: 801/750-2840). USU provides opportunities based only upon performance.

Staff Scientists/Ocean Margin Drilling Program. Joint Oceanographic Institutions, Inc. (JOI, Inc.) has immediate openings for two staff scientists to fill the positions of:

-Field Programs Coordinator
-Downhole Measurements Coordinator

in its Ocean Margin Drilling (OMD) Science Programs Office. Individuals filling each of these positions will report to the OMD Chief Scientist. They will be required to provide staff support to advisory committees in their area of concern, and will be responsible for implementing programs recommended by the OMD Science Advisory Committee, including oversight of the performance of individuals or groups under contract to JOI. Both positions require a Ph.D. in an appropriate area of earth science and appropriate experience. The OMDP is funded for FY '81. Initial appointment will be for a period of two years with the second year contingent upon the availability of funds. The positions may be filled on a rotating basis. Salary will be competitive. Send resume, statement of interest, and the names of three referees to Thomas A. Davies, Chief Scientist, Ocean Margin Drilling Program, Joint Oceanographic Institutions, Inc., 2600 Virginia Ave, NW, Suite 512, Washington, DC 20037. The deadline for applications is February 20, 1981, or as soon thereafter as suitable candidates are found.

NSF. The National Science Foundation, Division of Ocean Sciences, is seeking qualified applicants for the position of program director in the Physical Oceanography Program. The position is excepted from the competitive civil service. This appointment will be rotational for 1–2 years. The program provides support for scientists primarily from academic institutions to pursue fundamental research in physical oceanography. The selected candidate will carry out program planning and budgeting, proposal evaluation, administration of research grants, and liaison with other federal agencies. Applicants should have a Ph.D. in physical oceanography, a related physical science, or the equivalent, plus at least 3 years of specialized experience in physical oceanography. Field experience in an academic institutional program is highly desirable. Salary range is from $37,871 to $50,112.50, depending on qualifications and experience. Those interested in being considered for the position should send letters of interest and SF-171 or current resumes to the National Science Foundation, Personnel Administration, 1800 G St., N.W., Rm. 212, Washington, DC 20550. Attn: E. Paul Broglio. For further information call (202)357-7841.

NSF is an equal opportunity employer

Sediment Transport/Geological Oceanography. A tenure track position is available in the Department of Marine, Earth and Atmospheric Sciences at the level of assistant or associate professor. Applicants should have a thorough understanding of sediment transport, and a general background in geological oceanography. A Ph.D. is required. The candidate will be expected to strengthen the graduate teaching and research programs. The applicant's research interests can be theoretical, experimental, or observational, but must involve quantitative examination of marine sediment transport. Applicants should forward a resume, including a list of courses taken/taught, and the names of at least three references to Dr. Charles A. Nittrouer, Chairman, Search Committee, P.O. Box 5068, NC State University, Raleigh, NC, 27650. Application materials should be sent by March 31, 1981.

North Carolina State University is an equal opportunity/affirmative action employer.

Faculty Position: UCLA. Tenure faculty position—associate or full professor-in planetary atmospheric sciences. It is expected that an opening will soon become available for a senior scientist who has demonstrated accomplishment in the area of atmospheric sciences. Preference will be given to an individual whose interests are in atmospheric chemistry with particular stress on the composition and evolution of planetary atmospheres. The successful individual will have a joint appointment in the Department of Atmospheric Sciences and the Institute of Geophysics and Planetary Physics. Please send resumes to: Leon Knopoff, Institute of Geophysics, UCLA, Los Angeles, Calif. 90024.

UCLA is an equal opportunity/affirmative action employer.

Seismologist. The State University of New York at Binghamton has a vacancy for a seismologist at the assistant professor level. Candidates with research interest in exploration geophysics or earthquake seismology and a solid theoretical background are encouraged to apply. A Ph.D. with 0 to 5 years of teaching, research, and/or industrial experience is appropriate for the position. Salary is negotiable and competitive with academic institutions. Position is available in fall 1981. Please send resumé and the names of three references to Chairman, Geophysical Search Committee, Department of Geological Sciences, State University of New York, Binghamton, NY 13901.

State University of New York at Binghamton is an affirmative action/equal opportunity employer.

Geophysicist North Carolina State University—Raleigh. The Department of Marine, Earth and Atmospheric Sciences invites applications for a presently available tenure track position in geophysics. Rank and salary are open, depending on qualifications and experience. A Ph.D. is required. Applied or exploration geophysics orientation are preferable; however, other specializations in geophysics also will be considered.

Primary responsibilities will include generating and conducting research programs as well as teaching graduate courses in geophysics. The department currently consists of 31 regular faculty members including 18 in the areas of geology and geophysics. Please send resume and names of three references to Prof. I. J. Won, Search Committee Chairman, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27650, USA. We hope to make a final decision prior to May 31, 1981.

North Carolina State University is an equal opportunity/affirmative action employer.

Structural Geologist/University of California, Santa Barbara. Applications are invited for a tenure track appointment in structural geology to be filled during 1981-1982, subject to availability of funds. Rank dependent upon qualifications and experience, but preference will be given to the assistant professor level. Successful candidates must have Ph.D. degree and strong desire and commitment to teach and direct MA, Ph.D., and undergraduate students in both structural and field geology. He/she will be expected to develop a strong research program and obtain outside funding for its support. Additional duties may include teaching physical geology and summer field geology.

Please send resume and evidence of teaching and research proficiency, by March 31, 1981, and arrange for early submission of four letters of recommendation to Dr. Arthur G. Sylvester, Chairman, Department of Geological Sciences, University of California, Santa Barbara, CA 93106. (805) 961-3156.

The University of California is an affirmative action/equal opportunity employer.

Postdoctoral Position/Earth and Space Sciences Institute. To assist in analysis and interpretation of data from the Voyager Ultraviolet Spectrometer. Possible fields of research include the bound and extended atmospheres of Jupiter, Saturn, and Titan. Applicants should have a Ph.D. and expertise in several of the following areas: atmospheric physics, plasma physics, atmosphere—magnetosphere interactions, computer programming and simulation, and UV spectroscopy in the laboratory or space. Initial appointment for one year with the possibility for extension. Applicant should send resume, list of publications, and names of three references to Bill R. Sandel, Earth and Space Sciences Institute, University of Southern California, 3625 East Ajo Way, Tucson, Arizona 85713.

USC is an equal opportunity/affirmative action employer.

Boise State University. The Department of Geology and Geophysics anticipates two tenure track positions.

Field-oriented Structural Geologist with teaching or research interest in one or more of the following: economic geology, mineralogy, engineering geology, or geohydrology.

Geophysicist specializing in applied seismology with a second area of interest in either geophysics or geology.

Ph.D. is required for both positions. Send resume, with at least three references to Monte D. Wilson, Chairman, Department of Geology and Geophysics, Boise State University, Boise, Idaho 83725.

Boise State University is an affirmative action/equal opportunity employer.

COURSES

MSA Short Course on Kinetics of Geological Processes. The Mineralogical Society of America will sponsor a short course in Kinetics of Geological Processes, prior to the 1981 AGU Spring Meeting in Baltimore, Maryland. This short course, organized by Tony C. Lasaga and R. James Kirkpatrick, will be held from May 22–24. Speakers and topics to be included are: Introduction to Rate Theory-Global Kinetics-Geochemical Cycles, Antonio Tony Lasaga, Pennsylvania State University; Irreversible Thermodynamics in Petrology, George Fisher, Johns Hopkins University; Diffusion, David Anderson, University of Illinois; Transition State Theory and Defect Structure of Silicates, Tony C. Lasaga, Pennsylvania State University; Kinetics of Nucleation and Growth in Igneous Processes, R. James Kirkpatrick, University of Illinois; and Kinetics of Weathering and Diogenesis, Robert Berner, Yale University. For additional information and registration forms, contact MSA, 2000 Florida Avenue, N.W., Washington, D.C. 20009 (telephone: 202/462-6913). Registration deadline: March 31, 1981.

ANNOUNCEMENTS

1981 Rosenstiel Award. Nominations are invited for the 1981 Rosenstiel Award in oceanographic science.

This award, which is administered on behalf of the Rosenstiel Foundation by the Rosenstiel School of Marine and Atmospheric Science (RSMAS), University of Miami, recognizes outstanding contributions to marine science, including oceanographically relevant aspects of atmospheric science and fundamental developments in ocean engineering. The award consists of a cash prize, currently $5,000, and a medal. The recipient of the award will be invited to spend a week at RSMAS for discussions with faculty and students. The award will be presented at a banquet at that time.

To accommodate the multidisciplinary value of oceanographic science, the award recognizes, on a rotating basis, achievements in four broad disciplinary areas. In 1981 the emphasized discipline will be physical oceanography and air-sea interaction. The achievements recognized may consist of contributions toward the development of ocean science in general or of more focussed individual research of recognized impact on our understanding of the marine environment.

Nominations for the 1981 award for outstanding achievement in physical oceanography or air-sea interaction should be directed to the Interim Dean, Warren J. Wisby, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149, before 29 March 1981. Nominations should include a brief justification together with relevant references. The selection panel would especially welcome nominations of outstanding younger scientists whose early contributions suggest a continued role of leadership in the field.

Meetings

Radio Glaciology Workshop

A Radio Glaciology Workshop, organized by the World Data Center-A for Glaciology (Snow and Ice), will be held September 4–5 in Columbus, Ohio, in conjunction with the Third International Symposium on Antarctic Glaciology.

The workshop will focus on data acquisition and processing and data archiving and distribution. A working document will be produced that summarizes the key scientific, technical, and data management needs that relate to radio glaciology data acquisition, processing, archiving, and distribution.

For more information and for registration materials, contact Peter K. MacKinnon, WDC-A for Glaciology, CIRES, Box 449, University of Colorado, Boulder, Colorado 80309 (telephone: 303/492-5171).

Antarctic Earth Sciences Symposium

The Fourth International Symposium on Antarctic Earth Sciences will be held at the University of Adelaide, Australia, August 15–21, 1982.

The symposium tentatively will include technical sessions on the Archaean and Proterozoic record, southern ocean marine geology, solid earth geophysics, Cenozoic climate, plate tectonics, glacial geology, and Tertiary to recent volcanism. Two excursions are planned.

The symposium is sponsored by the Australian Academy of Science, the Australian Academy of Technological Sciences, the International Union of Geological Sciences, the Scientific Committee on Antarctic Research, the Geological Society of Australia, Inc., and the University of Adelaide.

For additional information, contact J. B. Jago, South Australian Institute of Technology, P.O. Box 1, Ingle Farm, South Australia, Australia 5098.

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